



Boosting the trench: Paleoseismic Record of Three Holocene Earthquakes Rupturing the Issyk-Ata Fault near Bishkek, North Tien Shan, Kyrgyzstan

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The evaluation of thrust paleoearthquakes and associated fault scarps is often hampered by the size of their cumulative fault scarps and interaction with sedimentary processes during interseismic periods. This is especially true if these events occur in areas undergoing low strain accumulation with long recurrence intervals. Furthermore, the earthquakes might occur in environments that provide limited datable material, rendering an event chronology difficult to develop. Here we present a paleoseismological study from one site (Belek) along the Issyk-Ata fault, a major range-bounding fault that constitutes the northern edge of the Central Tien Shan. The historic and paleoseismic record of this fault is limited, although it defines the southern boundary of Bishkek, the Kyrgyz capital. The only historically known earthquake ruptured along the Issyk-Ata fault in 1885 AD (M6.9). We use a range of tools, including photogrammetry, differential GPS, and 3D visualization and modeling, combined with different chronometers (IRSL, Radiocarbon) to boost the production of an event chronology from the trench stratigraphy and fault geometry. Our age control from both trench walls shows consistent age data in stratigraphic order irrespective of the chronometer. We were able to distinguish three different surface rupturing paleoearthquakes that affected the area at 8.9 ± 0.3 cal kyr BP; 4.7 ± 2.0 cal kyr BP; and $\sim 700 \pm 80$ cal yr BP, and interpret an extended episode of loess accumulation against the scarp between the oldest identified and penultimate events. Associated paleomagnitudes for the last two earthquakes range between M6.7 - M7.4 with a cumulative slip rate of 0.7 ± 0.2 mm/a. We did not find evidence for the 1885 AD event at Belek. Combined our results underline two major points: first, the historic and paleoseismic catalogue is incomplete; second, single ruptures do not necessarily involve the entire extend of the Issyk-Ata fault but point to segmented rupture behavior instead.